老年人的身體組成 —— 需要測定些甚麼?

Body composition and the aged: what needs to be measured?

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Within the gerontological and geriatric population studies in Gothenburg, Sweden, body composition studies have been performed with a four-compartment model (using whole-body potassium 40 counting and dilution of isotope labelled water) for two decades, the impedance method for some years and total body nitrogen determination by in vivo neutron activation technique for the last few years. Examples are given from a longitudinal study in 70-year-olds followed at the ages of 75, 79 and 81 years, and from a recent study of 75-year-olds.

Introduction

Knowledge of the composition of the human body is essential to both gerontology and geriatric medicine. Body composition reflects, however, not only genetic factors and environmental factors such as physical activity and nutrition, but also disease processes. Body composition is thus of great interest in the study, for example, of obesity, malignant disease, and geriatric clinical pharmacology and chemistry. Changes of body cell mass (BCM), fat, and total body water (TBW) occur frequently in disease, and changes with age in various distribution volumes may alter the pharmacokinetic and pharmacodynamic properties of drugs used in very old age. Measurement of the amounts of body fat and BCM is of value in the assessment of the net effect of energy intake and expenditure, and BCM is a better reference than body weight or body surface in the estimation of an individual's energy exchange and work performance.

For many decades, attempts have been made with a variety of methods to get an impression of the body compartments: these studies are reviewed in several studies[1–3]. The relatively new neutron activation analysis[4] seems to offer promise for research of the chemical composition of the body. Other methods include anthropometric measurements[5], isotope dilution of calculate TBW[6,7], and BCM[6], whole-body potassium (TBK) counting[6,8], and measurements of subcutaneous fat thickness by radiography[9], and with calipers[10]. Other approaches include modifications of conventional densitometry[11,12]. Other techniques to determine the amount of body fat include computer tomography[13], and measurement of total body electrical conductivity[14].

The present presentation

Within the gerontological and geriatric population studies in Gothenburg, Sweden[15,16], body composition studies have been performed with a four-compartment model (using TBK-40 counting and dilution of isotope labelled water) for two decades[6,17], the impedance method for some years[18], and total body nitrogen determinations by in vivo neutron activation technique for the last few years[19].

For this presentation, examples are given from a longitudinal study of 70-years-olds followed at the ages of 75, 79 and 81 years[20], and from a recent study of 75-years-olds[21].

A longitudinal study of males and females examined at ages 70, 75, 79 and 81[20]

Average BCM decreased by 1 kg in males and by 0.6 kg in females between the ages of 70 and 75, but decreased significantly from 75 to 79 years of age only in females. The correspondence between loss of body weight, and loss of BCM was higher in males than in females.

Regarding body fat it was found that while body weight decreased markedly in both sexes, the changes of body fat did not reach statistical significance.

The main reason for the decrease of body weight during the eighth decade of life was a decrease in TBW. This seems to be a feature of normal aging, although it might be counteracted by the fact that a change in cardiac and renal function might increase the amount of TBW in individuals also without obvious signs of heart or kidney disease.

Changes in the amount of TBW may be important especially in the elderly. Dehydration may be especially dangerous in elderly persons, because of the deficit in thirst and water intake which has been demonstrated by Phillips et al.[22].

Body fat estimation in 75-year-olds[23]

In this study we compared three different methods for body fat determination, namely from the four-compartment method, from body impedance measurements, and from body fat equations from skinfolds, namely according to Durnin and Womersley[5], and according to an equation derived from the present material.

Body fat according to the four-compartment method was 18.8 and 21.3 kg, according to the body impedance measurements 17.3 and 21.1 kg, according to the original equation by

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Durnin and Womersley 20.4 and 24.4 kg, and according to the equation derived from the present material 18.7 and 20.8 kg for males and females, respectively.

The differences between the body fat estimates from the two sets of equations were significant ($P<0.01$). Body fat derived from the equation of the present material was not significantly different from the estimates from the four-compartment method or the body impedance measurements.

What needs to be measured?

This depends on the conditions under study. TBW is important in geriatric pharmacology and dehydration states as dehydration is a prominent cause of clinical confusion. Body water can be measured by dilution of tritiated water or impedance measurements. However, interpretations should be made with caution in special groups of patients and in the highest age groups.

Body fat and lean body mass are of importance in the study of obesity and in geriatric rehabilitation.

Provided body fat equations from skinfold measurements are created and validated from skinfolds of the same age group they can be used as an estimate of body fat.

References

1 Moore FD, Olesen KH, McMurrey JD, Parker HV, Ball MR, Boyden CM. The body cell mass and its supporting environment. Philadelphia and London WB Saunders: 1963.

2 Steinkamp KC, Cohen NL, Siri WE, Sargent TW, Walsh HE. Measures of body fat and related factors in normal adults. 1. Introduction and methodology. J Chron Dis 1965; 18: 1279–1307.

3 Steen B. Nutrition in 70-year-olds. Dietary habits and body composition. A report from the population study of 70-year-old people in Gothenburg, Sweden. Näringsforskning 1977; 21: 201–223.

4 Harvey TC, et al. Measurements of whole-body nitrogen by neutron-activation analysis. Lancet 1973; ii:395–399.

5 Durnin JVGA, Womersley J. Body fat assessed from total body density and its estimation from skinfold thickness: measurements on 481 men and women aged from 16 to 72 years. Br J Nutr 1974; 32:77–97.

6 Bruce Å. Anderson M, Arvidsson B, Isaksson B. Body composition. Prediction of normal body potassium, body water and body fat in adults on the basis of body height, body weight and age. Scand J Clin Lab Invest 1980; 40:461–473.

7 Lindholm B. Changes in body composition during long-term treatment with cortisone and anabolic steroids in asthmatic subjects. Acta Allergologica (Copenhagen) 1967; 22:261–288.

8 Sköldborn H, Arvidsson B, Andersson M. A new whole body monitoring laboratory. Acta Radiolog 1972; Suppl 313:233–241.

9 Garn SM. Roentgenogrammetric determinations of body composition. Hum Biol 1957; 29:337–353.

10 Pascale LR, Grossman MI, Sloane HS, Frankel T. Correlations between thickness of skin folds and body density in 88 soldiers. Hum Biol 1955; 27:165–176.

11 Gundlach BL, et al. A rapid and simplified plethysmometric method for measuring body volume. Hum Biol 1980; 52: 23–33.

12 Garrow JS et al. A new method for measuring the body density of obese adults. Br J Nutr 1979; 42:173–183.

13 Tokunaga K et al. A novel technique for the determination of body fat by computed tomography. Int J Obes 1983; 7:437–446.

14 Presta E, et al. Measurements of total body electrical conductivity. Am J Clin Nutr 1983; 37:735–739.

15 Rinder L, Roupe S, Steen B, Svanborg A. 70-year-old people in Gothenburg. A population study in an industrialized Swedish city. I. General presentation of the study. Acta Med Scand 1975; 198:397–407.

16 Steen B, Djurfeldt H. The gerontological and geriatric population studies in Gothenburg, Sweden. Z Gerontologie 1993; 26:163–169.

17 Steen B, Bruce Å, Isaksson B, Lewin T, Svanborg A. Body composition in 70-year-old males and females in Gothenburg, Sweden. A population study. Acta Med Scand 1977; Suppl 611: 87–112.

18 Steen B, Bosaeus I, Elmståhl S, Galvard H, Isaksson B, Robertsson E. Body composition in the elderly estimated with an electrical impedance method. Compr Gerontol 1987; A1: 102–105.

19 Tölli J, et al. Total body nitrogen and potassium dermination in patients during cis-platin treatment. In: Yasumura S, et al., eds. In vivo bodly composition studies. New York: Plenum Press, 1990; 171.

20 Steen B, Lundgren BK, Isaksson B. Body composition at age 70, 75, 79 and 81. A longitudinal population study. In: Chandra RK, ed. Nutrition, Immunity and Illness in the Elderly. New York: Pergamon Press, 1985:49–52.

21 Schroll M, Steen B, Berg S, Heikkinen E, Viidik A. NORA — Nordic Research on Ageing. Functional capacity of 75-year-old men and women in three Nordic countries. Dan Med Bull 1993; 40: 618–624.

22 Phillips PA, Rolls BJ, Ledingham JGG, Forsling ML, Morton JJ, Crowe MJ, Wollner L. Reduced thirst after water deprivation in healthy elderly men. New Engl J Med 1984; 311: 753–759.

23 Gause-Nilsson I, Bosaeus I, Alpsten M, Sundh V, Steen B. Body composition in 75-year-olds — a comparison between three different methods for body fat determination (in preparation).